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1 JUNE 1982-31 MA..(U) FLORIDA UNIV GAINESVILLE CENTER
FOR MATHEMATICAL SYSTEM THEOR.. R E KALMAN 31 MAR 83
AFOSR-TR-84-0375 AFOSR-81-0238 F/G 12/1 NL

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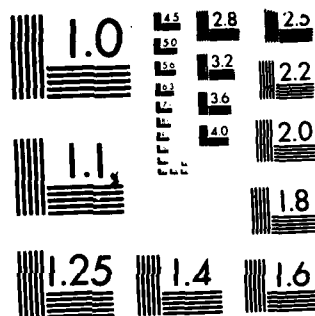
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INTERIM SCIENTIFIC REPORT

Air Force Grant 81-0238
1 June 1982 through 31 March 1983

Center for Mathematical System Theory
University of Florida
Gainesville, FL 32611

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Principal Investigator: Professor R. E. Kalman

During this grant period a substantial amount of previously begun work was completed and many papers have been published. See Appendix B for a full listing of the publication activities.

There was also a marked increase in general Center activities, due to expansion of the faculty (Professor Kamen, Khargonekar and Tannenbaum now being regular members of the Center) and also some concomitant increase in short and long-term visitors. In other words, the Center activities have been running at a smooth and rather intense pace.

The following is a summary of the main directions of research in the Center, supported or partially supported under this Grant:

(i) Linear systems over rings. An extension of linear system theory to more general classes of systems, for example, those including time delays. See papers by EMRE, KHARGONEKAR, ÖZGÜLER, POOLLA, and TANNENBAUM.

(ii) Control-theoretic problems by polynomial methods. This is a very active field in which the Center may probably claim global leadership. The main problems are pole-shifting and stabilization, study of feedback and compensation, regulator design, etc. See the dissertation of ÖZGÜLER and papers by him, HAMMER, KHARGONEKAR, KAMEN and TANNENBAUM.

(iii) Realization of covariance sequences. This work is concerned with the problem of building an efficient (low-order) model of a dynamical process or signal source from data concerning its autocovariance behavior. It is an attempt to put on a scientific basis some recent heuristic attempts such as the Maximum Entropy realization (AR scheme), Pisarenko's method, etc. The main work is contained in the dissertation of GEORGIU, as well as in

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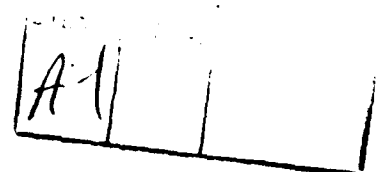
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a short paper by KALMAN [1982e]. This research has not been satisfactorily completed and is expected to continue.

(iv) Noisy modeling. A very ambitious new direction of research, of the utmost practical importance in many (especially "soft") fields, is the rethinking of modeling techniques in a noisy environment and especially the elimination of undue dependence of these techniques on arbitrary stochastic assumptions ("prejudices").

A historical review of the material, with a full explanation of the needs and backgrounds motivating the research, may be found in the dissertation of RIBERA. Other publications are mainly those of the Principal Investigator (see KALMAN [1983, 1982a, 1982b, 1982c]).



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Chief, Technical Information Division

AFOSR INTERIM REPORT 6/1/82 - 3/31/83

APPENDIX A

PERSONNEL SUPPORTED UNDER THE GRANT

(a) Regular Personnel

Professor R. E. Kalman, Principal Investigator (partial summer support only).

Mr. T. Georgiou, doctoral student (now on faculty of Florida Atlantic University, Boca Raton).

Mr. A. B. Özgüler, doctoral student (now at Marmara Scientific and Industrial Research Institute, Docaeli, TURKEY).

Dr. J. Ribera, doctoral student (now on faculty of IESE, Barcelona, SPAIN).

(b) Visitors (several lectures and/or extended visits)

J. C. Birget, University of California, Berkeley, CA

B. W. Dickinson, Princeton University, Princeton, NJ

R. Donagi, Harvard University, Cambridge, MA

R. P. Guidorzi, Bologna University, ITALY

J. Hammer, Technion, ISRAEL (now Case Western Reserve University, Cleveland, OH)

H. Kimura, Osaka University, JAPAN

A. Libgober, University of Illinois, Chicago, IL

T. Matsuo, Nagoya University, JAPAN

J. L. Rhodes, University of California, Berkeley, CA

E. D. Sontag, Rutgers University, New Brunswick, NJ

G. C. Verghese, MIT, Cambridge, MA

M. Vidyasagar, University of Waterloo, CANADA

Y. Yamamoto, Kyoto University, JAPAN

G. Zames, McGill University, CANADA

APPENDIX B

CENTER PUBLICATIONS

(a) Doctoral dissertations by Center students

T. GEORGIOU

- [1983] "Partial realization of covariance sequences", Ph. D. dissertation, Department of Electrical Engineering, University of Florida, 92 pages.

A. B. ÖZGÜLER

- [1982] "Skew-primeness in the regulator problem with internal stability", Ph. D. dissertation, University of Florida, 63 pages.

J. RIBERA

- [1982] "Identification of linear relations from noisy data", Ph. D. dissertation, University of Florida, 99 pages.

(b) Published papers by current members of the Center

E. EMRE, P. P. KHARGONEKAR, and A. B. ÖZGÜLER

- [1982] "Systems over rings: output regulation and tracking", Proceedings of the 21st IEEE Conference on Decision and Control, December 1982, pages 408-413.

F. HAMANO and G. BASILE

- [1983] "Unknown input present state observability of discrete time linear systems", Journal of Optimization Theory and Application, 40: 293-307.

J. HAMMER

- [1983] "Feedback representation of precompensators", International Journal on Control, 37: 37-61.
- [1983] "Pole assignment and minimal feedback design", International Journal on Control, 37: 63-88.
- [1983] "Linear dynamic output feedback: invariants and stability", IEEE Transactions on Automatic Control, AC-28: 489-496.

- [1983] "Stability and nonsingular stable precompensation",
Mathematical System Theory, 16: 265-296.

J. HAMMER and M. HEYMANN

- [1983] "Strictly observable linear systems", SIAM Journal on
Control and Optimization, 21: 1-16.
- [1983] "Factorization of linear systems: a generalized framework",
Linear Algebra and its Applications, 50: 321-352.
- [1981] "Linear system factorization", Proceedings of International
Symposium on System Theory, Bielfeld, W. Germany, June 1981,
3 pages.

R. E. KALMAN

- [1983] "Identifiability and modeling in econometrics", in DEVELOPMENTS
IN STATISTICS, edited by P. R. Krishnaiah, Academic Press,
Vol. 4, pages 97-136.
- [1982a] "Identification from real data", in CURRENT DEVELOPMENT IN THE
INTERFACE: ECONOMICS, ECONOMETRICS, MATHEMATICS, edited by
M. Hazewinkel and A. H. G. Rinnooy Kan, D. Reidel, Dordrecht,
pages 161-196.
- [1982b] "System identification from noisy data", in DYNAMICAL SYSTEMS
II, edited by A. R. Bednarek and L. Cesari, Academic Press,
pages 331-342.
- [1982c] "Identifiability and problems of model selection in econometrics",
in ADVANCES IN ECONOMETRICS, edited by W. Hildenbrand,
Cambridge University Press, pages 169-207.
- [1982d] "On the computation of the reachable/observable canonical form",
SIAM J. Control and Optimization, 20: 258-260.
- [1982e] "Realization of covariance sequences", in TOEPLITZ CENTENNIAL,
edited by I. Gohberg, Birkhäuser, pages 135-164.

E. W. KAMEN and P. P. KHARGONEKAR

- [1982] "A transfer function approach to linear time-varying discrete-
time systems", Proceedings of the 21st IEEE Conference on
Decision and Control, December 1982, pages 152-157.

P. P. KHARGONEKAR, T. GEORGIU, and A. B. ÖZGÜLER

- [1983] "Skew-prime polynomial matrices: the polynomial model approach",
Linear Algebra and its Applications, 50: 403-435.

P. P. KHARGONEKAR and A. B. ÖZGÜLER

- [1982] "The rings of stable rational functions: algebraic properties", Proceedings of the 21st IEEE Conference on Decision and Control, December 1982, pages 402-407.

K. R. POOLLA and P. P. KHARGONEKAR

- [1983] "Fractional representations for systems over a principal-ideal domain: a constructive technique", Systems and Control Letters, 3: 145-150.

A. TANNENBAUM

- [1983] "On the stabilizer subgroup of a pair of matrices", Linear Algebra and its Applications, 50: 527-544.

(c) Papers in the process or publication by current members of the Center

J. HAMMER and P. P. KHARGONEKAR

- [1981] "Decoupling of linear systems by dynamic output feedback", to appear in Mathematical System Theory.

E. W. KAMEN, P. P. KHARGONEKAR, and A. TANNENBAUM

- [1982] "Pointwise stability and feedback control of linear systems systems with noncommensurate time delays, to appear in SIAM Journal on Control and Optimization.
- [1983] "A local theory of linear systems with noncommensurate time delays", to appear in Lecture Notes in Control, Springer.

P. P. KHARGONEKAR and A. B. ÖZGÜLER

- [1982] "Regulator problem with internal stability: a frequency domain solution", to appear in IEEE Transactions on Automatic Control.
- [1981] "System theoretic and algebraic aspects of the rings of stable and causal stable rational functions", to appear in IEEE Transactions on Automatic Control.

A. TANNENBAUM

- [1982] "Polynomial rings over arbitrary fields in two or more variables are not pole assignable", to appear in Systems and Control Letters.

A. TANNENBAUM and P. P. KHARGONEKAR

[1983] "On weak pole placement of linear systems depending on parameters", to appear in Proceedings of thw MTNS, Beer Sheva, Israel and in Lecture Notes in Control Series, Springer-Verlag.

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